On the Extratropical Corals of Australia.

By the Rev. J. E. Tenison-Woods, F.G.S., F.L.S., Cor. Mem. Linn. Soc., N. S. W.; Hon. Mem. Royal Soc., N. S. W., Victoria, Tasmania, &c., &c.

Plates IV., V., & VI.

The *Madreporaria* or stony corals have two very distinct and very diverse habitats. One is for the most part tropical, the corals forming immense masses or reefs which form barriers, islands, fringing reefs, &c., of such extent as to occupy a very large and important portion of the surface of the Globe. The other is the home of small, simple or compound corals which live on the floor of the ocean in areas remote from coral reefs, and at all temperatures and depths even as much as 800 fathoms. The dredgings of the "Lightning," "Porcupine," "Challenger," and that of M. de Pourtales in the Gulf Stream, have made known a great number of these hidden forms of life. They have also cleared up many of the obscurities which a limited knowledge of species necessarily gave rise to. They have largely increased the list of both genera and species of corals. They have shown some of the extent to which variation affects those already known, thus uniting many forms hitherto regarded as distinct. Up to this time however, all these discoveries have had but little effect on the knowledge of Australian forms. It is true that the "Challenger" has visited these seas, but with what result may not be known for a long time. I may say that the extratropical *Madreporaria* of Australia have been literally untouched. Yet a special interest is attached to them on account of what has been made known through geological researches. It has been ascertained that our Eocene and Lower Miocene strata are particularly rich in the kind of corals with which we have to deal. As a test for the age and relations of the deposits no fossils could be more suitable. So far as they had been studied they have led to remarkable results. We have to thank Professor Duncan for being the first to enter upon the field. His industry and painstaking care, together with his almost unrivalled knowledge and experience in this department have been devoted to the subject,

and Australian science is deeply indebted to him for what he has effected. But while the fossil organisms have thus received such attention, the living forms have remained unknown, and this anomaly was the more unsatisfactory as consequently no satisfactory conclusion could be formed as to the age of the beds. Except a few forms of a wide range which had been dredged up in tropical seas, none of our corals were known to be living, and whether any or all of them might not be found still living in Australian seas there were no data upon which even to found a guess. It is true that some Australian corals had been cited by Messrs. Edwards and Haime from the explorations of various naturalists, most of all Messrs. Quoy and Gaimard, but none of them were deep-sea forms, and only very few Australian, New Zealand being the place where the most abundant collections were made. Professor Duncan has with great care extracted all the corals referred to as Australian from various works, principally however from the *Histoire Nat. des Corallaires* of Messrs. M. Edwards and Haime. This list, as I shall show hereafter, gives no reliable information. Naturalists have had a custom of noting as Australian all the species that were found there. This would convey no more information than if a species were labelled Africa. The result is that tropical and reef building forms have been confounded with simple and extratropical *Madreporaria*, which does not give the slightest help towards elucidating the relations of our Australian fossil forms. We must add to this the confusion arising from geographical mistakes, very common among the older French naturalists. The species are often called Australian, which come from the South Pacific Islands, and "Terre de Van Diemān" of North Australia has been cited as Tasmania. I need hardly say that with my limited opportunities for comparison, &c., I did not think of approaching the subject with a hope of throwing any light upon it, or lessening the confusion. In my geological and zoological studies extending over 23 years of a life in Australia, I have often met specimens of corals both living and fossil; some of them I sent home to men of science, and some I have kept by me or presented to

museums. I was not aware of the extent of the knowledge thus acquired until I compared my own notes and specimens with Professor Duncan's list (*Quart. Jour. Geol. Soc.*, 1870, p. 311.) Then I found that I had considerable material, but which I scarcely knew how to use. If I could have sent it all to London I should have served the interests of science better than I can do now; but this was out of the question, for many of my notes and drawings referred to specimens in public museums or private collections which I could not dispose of as I wished. At this time the Hon. W. Macleay placed at my disposal for examination and description his small though interesting and valuable collection, and this made me decide upon trying to draw up the present monograph. It will be due to men of science to mention the only works I have been able to consult in preparing this monograph. They are as follow: Histoire Nat. des Corallaires, 3 vols., and Atlas of Mess. Ed. and Haime; the monographs of the same authors in the Palæontographical Soc. publications; the monographs of Professor Duncan in the same, as also all his papers in the Journal of the Geological Society; all the papers of various authors in the Annals of Nat. Hist.; the Proceedings and Transactions of the Zool. Soc. London; the Annales des Sciences Nat.; the Voyage de l'Astrolabe; Voyage de la Coquille; Sir W. Thomson's Depths of the Ocean; Dana's Coral Reefs; Darwin's Coral Reefs; Ellis and Solander's Zoophytes; Gosse's Actinologia Britannica; Juke's Voyage of the Fly; Voyage of Rattlesnake; Lamarck His. Nat. des Ani. s. vertebres, 2 edit., par Deshayes; Gray's Brit. Museum Catalogues and a few Articles in Nature; Prof. Verril's essays in the Amer. Jour. Science and Art, the Geological Magazine, and a few other serials.

A study of the Australian living forms has shown that some of the fossil species thought to be extinct are still existing. They are *Trochocyathus Victoriæ*, *Sphenotrochus variolaris*, nobis. There are also forms which have a remarkable relation with extinct species, viz: *Conocyathus zelandiæ*, Duncan, which was not known as Australian, and which bears a strong resemblance to the extinct European Miocene form, *C. sulcatus*. There are two if not three species of

Conocyathus amongst our fossil corals. There are two new species of *Deltocyathus* amongst the *Madreporaria Aporosa;* I have found only one species of *Balanophyllia* which is all the more remarkable as the genus is so abundantly represented in the Muddy Creek and Geelong strata. But I have been able to add a new species to each of the remarkable and rare genera, *Endopachys* and *Heteropsammia.* It would be almost useless to form any conclusions from the very few observations which have resulted in the discovery of a few new species, yet I may say that what we have discovered after a very few dredgings, show us plainly what might be expected from an extended series of operations. So far as we have learned the coral fauna of New Zealand is very distinct from the Australian. If the observations of Messrs. Quoy and Gaimard are to be relied upon, the northern end of New Zealand possesses forms which are never found out of the tropics in Australia, and very far within the tropics as well. I refer to *Porites Gaimardii* and *Polyphyllia pelvis.* If they were not found alive I should doubt if they were not brought from some of the Pacific Islands. Among the simple corals, *Conocyathus zelandiæ* is the only form which I know of as common to both Australia and New Zealand. We have no data for showing what relation there is between Tasmania and Australia in the coral fauna; but as most of the simple corals have a wide range and do not seem to be restricted by a cold temperature, there is probably very little difference in the species.

The only corals on the south and S.E. coasts of Australia which could in any sense be called reef-building forms, are one or two species of *Stylaster*, and one or two of *Plesiastræa.* Both of these are littoral, and grow in tufts or small masses, but never in anything more than the merest patches. *Stylaster*, though not uncommon about Port Jackson, has not been found as far as I am aware on the south coast, while *Plesiastræa* seems to extend from Port Jackson right round to South Western Australia.

Amongst the new species here described there are two for which I have been obliged to erect two new genera. One is a parasitic coral of minute size which has grown on the base of

that singular Polyzoary named by Prof. Busk, *Lunulites cancellata*. The other is a form which approximates to *Ceratotrochus* but differs in the absence of any special ornamentation on the ribs and the wide deep calice, with a very large hispid and spongy columella, and a broad attachment.

In referring to these corals as extratropical, I must define what I mean by the term. The reef-builders are not exactly confined to the tropics in N.E. Australia; they extend a little beyond it and may be found as low as lat. 28° S., or even lower. It seems to me that there was formerly a prolongation of the Barrier Reef to the south. If the map of N.E. Australia be consulted it will be seen that to the north of Moreton Bay there is a large island jutting out somewhat east of north. This is marked on the maps as Great Sandy Island, but is locally known as Frazer's Island. It is separated from the coast line on the south, by Wide Bay. The land on both sides seems to consist of immense drifts of red and yellow sand irregularly stratified. To the north the island ends in a coral reef called Break-Sea Spit, and then the reefs are continued with long interruptions in islands and coral shoals, including Lady Eliot's Island, Bunker's group, Capricorn group, &c., until the Barrier Reef is reached. Strictly speaking, Wide Bay may be said to be the commencement of that inner channel which continues inside the Barrier Reef right up to Cape York, a distance of about 1200 miles. It would be more convenient therefore, in the study of Australian corals, to designate as belonging to the extratropical fauna, all south of Breaksea Spit. Of the west side I can say little or nothing. The shell fauna of Perth has certainly more of the Indian Ocean in its *facies*, than Australia; and the raised beaches of Freemantle are unquestionably tropical in their fauna. I should incline to the opinion that the extratropical fauna should not be made to extend beyond the south west cape, Cape Leuwin. The coral reefs of Houtmans Abrholhos are in lat. 28·59.

I must add a few words as to the classification of corals which I am sure will become daily a greater matter of difficulty, as the variation of different species comes to be better understood. In

spite of the immense work that has been done by Messrs. Dana, Milne Edwards and Haime, and the careful elaboration that has followed from such industrious observers as Professors Duncan, Verrill, Messrs. Gosse and Wall, there is a very great deal of confusion and obscurity attached to the subject. It will be seen in this essay that the classification is founded on the presence or absence of pali, columella, costæ, epitheca, endotheca, synapticulæ; the structure of the wall and character of the endotheca, the edges of the septa and the mode of division or spreading. Now the nature and offices of the various organs first enumerated, are not understood, and the organs themselves are not defined in a satisfactory manner. Pali may be regarded by some as lobed septa, or *vice versa*; epitheca is a mere external secretion to protect against injury, an organ often present and absent in the same species; the septa united in the centre may be called a columella, or it may then be stated to be absent. Endotheca and synapticulæ may graduate into one another, and synapticulæ may result from the union of granules on opposite septa, and thus two such widely sundered groups as Turbinolidæ and Fongidæ, be united.* The costæ also are subject to great variation, and in a species of *Cylicia* to which reference will be hereafter made, one of the many calices had a series of buttress-like costæ thrown out on the outside of the epitheca. All these things show that a sound classification of the *Madreporaria*, is yet to be found. The work of Messrs. Edwards and Haime is a wonderful monument to their genius and industry; but like the beautiful and apparently simple system of Linnæus, is too artificial to be practically useful as the knowledge of the subject increases.

The greatest difficulty with me has been the pali. Professor Duncan (in the *Proc. Zool. Soc. for* 1876, *p.* 435), says:—"There is some difficulty in classifying certain species on account of the very arbitrary manner in which certain modifications of the internal parts of the septa are decided to be pali. Pali, in the strict and proper sense, should arise from the internal base of the

* This has actually occurred; one species of *Heterocyathus*, being removed to *Stephanoseris* because of the granules of the opposite septa uniting.

corallite and should be placed between certain septa and the columella, or the anal space, when this last is deficient; they may adhere to the septa, but in either case the ornamentation and general arrangement of the sclerenchyma of the pali differ from those of the septa; a row of pali infers an extra row of tentacles. But the term pali is given to prominent dentations of the inner margins of septa, or to the inner margins when their dentation differs from the rest of the septa as in *Phyllangia*, for instance. This is not correct; such structures may be called papillose, but this will not permit of the corallites being classified as having pali." In another place, the same author says, (p. 432) :—"The importance of deciding the true character of the structures is great, for whilst the septal spine may be of specific importance, the presence of the pali as independent structures is generic, for it involves the presence of other tissues; such for instance, as an extra crown of soft tentacles. Every one who has seen many of the small sessile corals usually called *Astrangia*, *Phyllangia* and *Ulangia*, amongst the *Astrangiaceæ* must have felt this difficulty. In some, the spinose character of the false palus is evident, but in other species an arbitrary custom appears to have decided that such and such are not septal structures but pali."

It seems to me that there is almost the same difficulty in a different way as to the columella, as I have before remarked, and so also as to the costæ which are sometimes clearly only extra mural septa, and sometimes quite distinct from other tissues. A good many of the difficulties might be met for the present by most exactly defining the terms and introducing a few new ones.

I propose to follow up this paper by another on the corals of the Chevert Expedition, which will principally include tropical forms.

The Class Polyps, to which Corals belong, comprises radiated aquatic animals which have only one orifice which is surrounded with tentacles, the body being hollowed out, and forming open and intercommunicating cavities in which are contained the reproductive organs.

The class is divided into sub-classes, namely—1. Cnidaria,*

* From *κνιδη*, applied by Aristotle to the Jelly Fish, which he also called *ακαληφη*.

animals with tubular tentacles disposed in a crown, and communicating with the visceral chamber; and 2. PODACTINIA.

The CNIDARIA are divided into two orders—1. ALCYONARIA, 2. ZOANTHARIA, which latter have simple tentacles or ramifying irregularly and increasing with age.

The Zoantharia are again divided into three sub-orders, viz.:—1. ACTINIA, always soft in every part; 2. ANTIPATHARIA, with a coriaceous axis and a tissue full of spiculæ; 3. MADREPORARIA, with a stony calcareous axis.

The *Madreporaria* are known by the stellate structure of their polypodom, which arises from the septa or divisions of the visceral chamber. We distinguish in each chamber—1. The *septa;* 2. The *calice* or cup-like depression of the summit; 3. The *columella* or central mass or column independant of the septa and springing from the base; 4. The *wall* or partition which bounds the whole chamber; 5. The *costa* or ribs outside the wall which often seem identical with the septa, but generally are quite distinct from them. *Madreporaria* are divided into five sections—1. *Aporosa,* or those on which the tissue or sclerenchyma is compact; 2. *M. Perforata:* sclerenchyma perforated; 3. *M. Tubulata:* tubular; 4th. *M. Tabulata:* visceral cavity subdivided by stages or floors, and the septa rudimentary or hexameral; 5. *M. rugosa:* sclerenchyma tabulated, but the septa well developed and tetrameral.

By far the greater portion of our stony corals belong to the first section of *Madreporaria Aporosa,* indeed they include the larger portion of the whole class. It should be borne in mind therefore that in this section the visceral chamber is open or free, being only transversely subdivided by irregular projections. The septal apparatus is well developed, and the sclerenchyma or stony matter of the wall, &c., is compact.

This section includes eight principal groups—1. *Turbinolidæ;* 2. *Dasmidæ* (fossil); 3. *Oculinaceæ;* 4. *Stylophorinæ;* 5. *Echinoporinæ:* 6. *Astreidæ;* 7. *Merulinaceæ* (one genus only); 8. *Fungidæ.*

The first family concerns us the most. It is composed entirely of solitary corals. The wall is quite imperforate and not covered by any outer sheath *(epitheca)*, though sometimes there is a sort of basilar sheath. The septa are free laminæ with entire edges, and often granular, which granules never unite from side to side to form what are termed *synapticulæ;* there is no inner sheath *(endotheca)* so that the chambers are open for all their extent to the base. In many species the columella is absent or the septa unite in the middle *(Conocyathus zelandiæ* of Australia), but sometimes it exists, and between it and the septa there are certain laminæ arising from the base or the inferior portion of the septa. These are called *pali.* In the *Turbinolidæ* the pali have an existence independant of the cycles though they are in the line of their prolongation. They are generally absent from the septa of the last cycle.

This peculiarity gives ground for subdividing the large family into two subfamilies—1. *Caryophyllinæ*, with one or many circles of pali; 2. *Turbinolinæ*, from which pali are completely absent. The first subfamily is again divided into—1. *Caryophyllaceæ:* one circle or crown of pali; 2. *Trochocyathaceæ*: many circles or crowns of pali.

Genus Caryophyllia, *Lamarck*, 1801.

Corallum attached and simple, with one row of pali; wall bare, more or less raised; columella crisped; pali broad; costæ simple.

Professor Duncan regarded a fossil coral from Muddy Creek as belonging to this genus, but the specimens sent to him were imperfect. A large series of well-preserved fossils has induced me to refer this species to the genus *Deltocyathus.* We have no true Caryophyllia known in the Australian seas, though the genus is well represented in the Atlantic and British seas. We have none fossil though simple pedicellate corals are also well represented, but they are intimately related to the existing forms, and more in alliance with extinct European fossils than with what survives in Northern seas.

Genus CONOCYATHUS, *D'Orbigny*, 1849.

Coral simple, trochoid, straight, without trace of adherence; costæ sublamellar; septa exsert and laterally granular; *no columella;* pali penultimate and well developed.

This genus was known by one species hitherto, described from the Miocene of Mayence, but said to be identical with one very common at Port Jackson (Sow and Pigs reef, about 16 fathoms.) I do not believe that the species are identical, but the diagnosis of M. Milne Edwards is so very meagre that I give the specific name with my notes for other naturalists to follow up. "CONOCYATHUS SULCATUS, *d'Orbig. in M. Ed. & H., Poly. foss. des. terr. palæoz., p.* 20, 1851, also *d'Orb. Prod. de Paleont. tom.* 3, *p.* 145, 1852. *M. Ed.*, remarks that this species resembles *Turbinolia dispar* exteriorly, except that the costæ are a little less thick and fewer; three complete cycles; septa unequal, somewhat thick; six broad and thick pali, in front of secondaries." *Hist. Nat. des. Cor., Vol.* 2, *p.* 25. My diagnosis is:—Corallum of regular conical form, not much elongated; base less than half the width of the calice; transverse section perfectly circular throughout; costæ numerous, forming four cycles closely set, equal, somewhat projecting, the secondaries arising from the base and being with the first thicker at their origin, becoming sharp and thin higher up, tertiaries arising a short distance from the base, but those of the fourth order at about a third and the fifth in the upper half of the corallum; intercostal furrows about width of costæ, not very deep, with a regular single series of rather distant pores (?); scarcely any perceptible calicular fossa; columella undistinguishable as the septa all unite in the centre, but there are two small lobes visible in a depression in the centre of the pali; septa in six systems of three cycles, and there are none to correspond with the fourth cycle of costæ. The secondaries are thinner until united with their pali, which rise in high falcate crests round the centre, being much more exsert than any of the septa; the primaries are more exsert and larger in size than the secondaries, and the tertiaries bend regularly round and unite with the pali, being thickened at the point of junction; pali

before the secondary septa only, and some almost styliform and more exsert than others; they are with the septa only faintly granular occasionally and never spinously granular *(echinulé)* as stated in the case of *C. sulcatus*.

Seven specimens of this very interesting coral were dredged by Mr. Macleay, off Port Stephens, at 71 fathoms. The average size of all the specimens, $6\frac{1}{2}$ millim., with a diam. at the calice of $3\frac{1}{2}$.* It is in all respects a *Turbinolia* with pali, instead of a columella. It most resembles *T. Fredericiana*, Ed. and H. in the form and in the costæ being a cycle in advance of the septa, but the junction of the tertiary with the secondaries is not by sloping towards them, but by bending round and thickening. It is, as already observed, common at Port Jackson.

Conocyathus cyclocostatus, *nobis*. See *Proc. Roy. Soc., N. S.W.*, 1877.

Conocyathus fenestratus, *nobis, loc. cit.*

Conocyathus compressus. n. s. Plate V, fig. 1, a & 6.

Corallum cuneiform, very much compressed at the base, which is sometimes pointed. No trace of adhesion. Calice *narrowly elliptical* and shallow; septa in six systems of four cycles, very slightly exsert, rounded and almost grooved and serrated at the edges; all the orders quite straight, primaries and secondaries equal; pali equal, tall, thin, rounded and before all the orders except the last, and form a compact mass in the centre with the septa; costæ distinct to the base and in cycles corresponding to the septa; primaries and secondaries distinct to the base, tertiaries arising a very short distance above them, fourth and fifth orders a third of the height from the base; all smooth or very faintly granular. Intercostal spaces shallow, not apparently pitted. Alt. 8-10. Maj. axis $6\frac{1}{2}$-7, min. axis $3\frac{1}{3}$-4. mil. Off Port Stephen's, 71 fathoms. W. S. Macleay.

* I have since met specimens double the size given. Professor Duncan has named the New Zealand specimens *C. Zealandiæ*, and I have no doubt they are identical with ours.

Two specimens of this very interesting coral are in the Macleayan Museum. It differs very much in the form of its pali and in general shape from all our other species, and is more like *Deltocyathus viola*. But the pali do not unite to one another, though they are united to the septa, being little more than lobes.

Trochocyathaceæ.—Pali in many circles round the columella.

Genus Trochocyathus, *M. Ed. and H.*, 1848.

Corallum simple, pedunculate or subpedicellate, or with only faint traces of adherence; columella well developed, composed of bundles or series of prismatic or twisted processes; pali well developed, entire, free to a great extent, unequal according to the cycles to which they belong, and present before all the cycles except the last; septa exsert, broad, and laterally striate; wall bare, or with only a rudimentary epitheca.

All the known species are fossils extending from the Lias to the Pleistocene, but most numerous in the Miocene. There are two fossil species in New Zealand, figured, but not described in the *Quart. Jour. Geol. Soc., Vol.* 6, 1850, *p.* 331, *pl.* 28, *fig.* 18 *and* 19. Milne Edwards doubts if they can be arranged under the genus (see *Nat. Hist. des. Cor., Vol.* 2, *p.* 46). They are both from Pleistocene beds in Onekakara, New Zealand, and are named *Trochocyathus hexagonalis*, and *T. Mantelli*, *Ed. & H. ut supra.*

2.—Trochocyathus Meridionalis. *Duncan.*

The corallum is short and hemispherical in shape, marked externally by subequal costæ, and a depression at the base, small, and circular in outline. The costæ are separated by distinct intercostal spaces, are very prominent at the calicular margin, and faintly marked with wavy swellings, and their external surface near the base has a row of rounded granules. The primary and secondary are slightly larger than the tertiary, and the higher orders are smaller than the latter. The calice is circular in outline, and shallow. The septa are distinct, unequal, distant and smaller than the costæ. They are broad externally, and exsert, but they soon become narrow, granular laterally, and depressed below the circular margin. There are four cycles in six systems :—

the primary are the largest, and are connected with the largest and most prominent costæ; the secondary are smaller; and the smallest septa, *i. e.*, those of the fourth and fifth orders, only unite with the tertiary far inwards. The granules are large, and appear to increase in size towards the columella. There are pali before all the septa except those of the last cycle; and the upper edges of the septa pass upwards and inwards to reach the pali, which are small, long and granular. The tertiary pali are more external than the others; and all are united laterally by a spongy tissue, so as to form a ring higher than the septa in the body of the calice. The ring occupies much space, forms the outside of the columella; and within the ring is a deep fossula, at the bottom of which the hard and flat centre of the columella is seen, Height of the corallum, $\frac{3}{10}$ inch; breadth of the calice, $\frac{5}{10}$ inch. Locality, No. 7, $2\frac{1}{4}$ miles east of the river Gellibrand.

TROCHOCYATHUS VICTORIÆ, *Duncan*.

The following is Prof. Duncan's diagnosis of the fossil form. Corallum subturbinate, compressed base elongate and nearly in shape of a ridge; calice elliptical, shallow; costæ slightly waved. distinct, subequal, prominent, rounded, ornamented on free surface by circular disks with a central boss-like swelling or by moniliform swellings, covered with a pellucid structure, which, when worn, represents the outside of the disk; slightly granular laterally; calicular margin broad, wall stout, septa smaller than costæ, rather exsert, soon becoming thin, granular laterally, rather wavy, long, wide apart, unequal, higher orders long; turned towards the tertiary near the columella, four cycles, six systems; pali slightly broader than septal ends, long and granular, before all septa except 4th and 5th orders; columella essential, spongy, small. Alt. $\frac{4}{10}$, calice long. $\frac{10}{30}$ lat. $\frac{8}{30}$ of an inch. Loc. Strata $2\frac{1}{4}$ miles east of river Gellibrand. A taller variety with base filled up with sclerenchyma, longer costæ, and more distinct ornamentation. Worn fossils present very distinct costæ and an uneven free surface, occuring in a dark shale in numbers together.

This species occurs living between Port Jackson and Port Stephen's of double the size mentioned here. The costæ are in cycles corresponding to the septa. It is very rare.

There are slight differences between Prof. Duncan's description and the living form. The ornamentation of the costæ is subspinous, and the columella is a linear series of very granular papillæ which send off processes to the septa. The pali are in reality only deep lobes of the septa. This is a case where, according to Prof. Duncan these processes should not be regarded as pali at all, yet I have very little doubt that these single lobes perform the offices of these organs and that there is an extra crown of tentacles on the animal. Some of the primary septa send forth transverse spinous processes at the origin of the pali.

New Genus DUNOCYATHUS.

Corallum simple, parasitic; base and side entirely immersed in calcareous foreign body; one row of pali.

This genus is erected for the reception of immersed and parasitic corals of the Caryophyllian group of simple Turbinolidæ; consequently it possess pali, but as it is immersed nothing can be said about the costæ, base, &c. The name was taken from Δύνω, immersed or sunk. Only one species has as yet been found, but the necessity of a separate genus for its reception is quite obvious, The appearance of the entire pali and columella would place it close to Paracyathus.

DUNOCYATHUS PARASITICUS, N. S., Pl. 5, Fig. 4, a & b.

Corallum entirely immersed in the base of *Lunulites cancellata*, Busk, the wall being slightly curved outwards. Calice circular and shallow; septa in six systems of three cycles; primaries and secondaries of equal size, very slightly salient but sloping away from the sides; the edges denticulate or set with irregular lobes and points, and both surfaces set with very coarse projecting granules. Columella with a papillary summit united below to the pali which are indistinct, confluent and sending forth horizontal traverses to the septa so as to form irregular horizontal laminæ from which the columella rises. Diam. 2 millim. Off Port Jackson, 45 fathoms. J. Brazier.

This singular coral is not unlike *Paracyathus Thulensis*, Gosse, except that it has only three cycles. Set in the base of a *Lunulites* it makes the conical polyzoary not unlike a complete *Turbinolian*, but the calice does not fill up the whole of the base, and is not usually symetrically placed.

Genus Deltocyathus. *M. Edw. & H.*, 1848.

Corallum free and without trace of adherence, calice shallow, columella pluripartite; pali entire, highly developed, principally those of the penultimate cycle which is directed towards the antipenultimate so as to form chevrons or deltas. There are none before the last cycles. Costæ granular and distinct to the base.

Deltocyathus italicus. *M. Edw. & H.*

Corallum a short cone; calice circular; septa very slightly exsert, thickened exteriorly, of four complete cycles and six systems; columella fascicular; pali thick and very unequal; costæ in cycles regular and granular. This occurs fossil in the Italian Miocene, and still exists in the Carribean Sea. It is not uncommon in the Geelong and Cape Otway beds, but has not been found at the Muddy Creek, Mount Gambier, or in Tasmania.

Deltocyathus viola. *Woods & Duncan.*

This species was long mistaken for a *Caryophyllia*, because when worn the deltoid pali became eroded, looking like a single circle before the tertiaries. I have described and figured a perfect specimen in the *Proc. Roy. Society*, N. S. Wales, 1877.

Deltocyathus rotæformis. n. s., Pl. 5, Fig. 2, a & b

Corallum circular, depressed, with perfectly flat base which is coarsely granular and so thin that it is frequently worn through and shows the radiating septa; calice circular in outline, fossa very slightly sunk; septa in six systems of three cycles; primary and secondary equal but the former much more exsert and projecting high above the calice; tertiary short and without pali. All granular; pali united to the inner edges of the first and second cycles and throwing out thick transverse processes at their junction. Columella papillary; granules of the base vermicular

costæ springing from the edge of the base and quite distinct, straight, flat, broad or circular and seen from above look like pillars, very finely granular equalling the interstices in thickness and projecting above the edge of the calice forming protuberances which *alternate with the costæ*, being equal in number with them. The wall is quite distinct from both septa and costæ. Diam. 4-6. Alt. 3-4½ mil.

Six specimens of this remarkable species were dredeged up at 71 fathoms off Port Stephen's by Mr. Macleay. It departs very much from all our other species in its shape and in the wall, the pali and in the peculiar costæ which alternate with the septa.

Sub Family TURBINOLINÆ. Pali entirely absent.

Genus SPHENOTROCHUS, *M. Edw. & H.*, 1848.

Corallum simple, free, and without trace of adherence, straight and cuneiform ; calice elliptic ; columella lamellar, extending horizontally along the greater axis of the cup ; septa few and exsert ; costæ broad, either smooth, crisped or papillary.

SPHENOTROCHUS VARIOLARIS, *Nobis.*

This species has been fully described and figured by me as a fossil in the *Proceedings Roy. Soc.*, N. S. Wales, 1877. It exists on the South East coast, three specimens having been dredged up by Mr. Macleay, off Port Stephens, at 71 fathoms, and Mr. Brazier has obtained others.

SPHENOTROCHUS AUSTRALIS, *Duncan.*

This name was given by me to a specimen sent to England in 1864. It is described and figured by Professor Duncan in the *Jour. Geological Society* for 1870, p. 297. It is rather a common fossil in the Muddy Creek beds. It is not known to be living.

Corallum compressed, angular and deeply excavated inferiorly, long axis double the length of minor ; costæ broad, wavy, well-defined and descending to ends of lateral processes ; calice not shallow, elliptical ; columella long, lamellar ; primary and secondary septa joined to columella, not exsert, smooth ; all septa

well developed in three cycles and six systems, not corresponding to the costæ. In some specimens there are a few septa of a fourth cycle. Alt. 6 to 10, long. 3 to 5, lat. $1\frac{1}{2}$ to 2 mil.

SPHENOTROCHUS EXCAVATUS, N. S., Pl. 4, Fig. 1, a, b, c.

Corallum tall, broadly cuneiform, only slightly narrower and more compressed at the base; calice elliptical, the axis being as 4 to 3; ends of major axis somewhat depressed below minor; septa moderately exsert, smooth, except a granular exterior margin, sending forth many long processes into the fossa which sometimes curve upwards and at the base unite with the columella; in six systems of three cycles, primaries and secondaries nearly equal, tertiaries almost rudimentary, but very thick and becoming stouter outside the wall; fossa very deep and open; columella a narrow short lamellar plate projecting very little above the base of the calice, scarcely extending horizontally one-sixth of the length of the major axis; costæ in systems corresponding to the septa, the primaries and secondaries suddenly thickening and becoming very coarsely granular and rugged to the base, especially laterally, where they almost assume the form of crests or ridges; tertiaries continuous and simple, desisting at about one-fourth from the base; all very granular and almost crested. Port Jackson, rare. J. Brazier. Alt. 10, major axis 6, minor $4\frac{1}{2}$, at base 5 and $2\frac{1}{2}$.

Genus SMILOTROCHUS, *M. Edw. & H.*, 1851.

Corallum simple, straight, cuneiform, free and without trace of adherence; no columella; septa finely granular, a little exsert; wall bare, showing simple distinct costæ. Further on I have given reasons why this fossil should be considered the type of a new genus.

SMILOTROCHUS VACUUS, *nobis.*

This is a fossil species from the Muddy Creek which has been described by me and figured in the *Proceedings of the Roy. Soc.*, N. S. W., for 1877. All the known species have the septa united or confluent at their inner edge, but this species has a deep well in place of the columella.

Genus CERATOTROCHUS, *M. Edw. & H.*, 1848.

Corallum simple, subpedicellate, in the adult state columella highly developed and fascicular; septa broad and exsert; wall bare, with costæ distinct to the base, the principal of which are variously ornamented.

CERATOTROCHUS FENESTRATUS.

Is a species described by me in the *Roy. Soc. Proc.*, N. S. W., loc. cit., but which now I have considerable doubts whether it should not be regarded as a *Dasmia*. I shall return to the subject shortly in a future paper on our fossil corals.

New Genus CRISPATOTROCHUS.

Corallum broadly adherent; septa small; fossa broad and deep; columella highly developed, crispate; costæ simple, distinct, granular.

Differs from *Ceratotrochus* in being broadly adherent with very simple costæ, broad and deep fossa and small septa.

CRISPATOTROCHUS INORNATUS, N. S. Pl. 6, Fig. 2, a, b, c.

Corallum turbinate, constricted above the base, which is two-thirds the width of calice; transverse section subcircular, compressed laterally; costæ corresponding to septa, broad, flat, separated by a finely depressed line, but becoming more distinct and separate at the edge of calice with many not very prominent granules; calice broadly elliptical; axis as 10 to 8; septa in six systems, four cycles, little salient, thick externally, granular and slightly flexuous internally, those of the 3rd order especially; primaries and secondaries equal, scarcely larger than the tertiaries, while the fourth and fifth orders differ a little in size; all the orders somewhat exsert, but the 1st and 2nd especially; fossa wide and deep; columella very large, crispate, of spongy, twisted tissue, or broad rounded lobes more like the centre of a cauliflower. Alt. 12, maj. axis 10, min. 8, diam. of constriction 5, of base 7, mil.

One specimen only in the Macleayan Museum, dredged at 80 fathoms, off Port Stephens.

This coral is distinguished by the small number of cycles (in which respect it resembles *Paracyathus crassus*, Ed. and H.) by the depth of the calice, and the septa being so slightly salient, which makes the columella a very prominent feature. It is more like the fossil species than any at present living. In this specimen one half the cup is covered and obliterated by a silvery *Millepore* (?)

Second Division Flabellaceæ.

Wall entirely covered by a pellicular epitheca.

Genus Flabellum, *Lesson*, 1831.

Corallum simple, straight, compressed; calicular fossa narrow and deep; columella represented by a few spiniform processes on the internal edge of the septa; the latter numerous and subequal, so that the cycles and systems are very difficult to distinguish; they belong to six primitive systems; they are not exsert, and have well-marked radiated series of granules, the wall often furnished with crests or spines. M. Edwards adds that they never have radiciform processes.

Flabellum spinosum, *M. Ed. & H.*

Corallum much compressed, deltoid, of somewhat less than a right angle, and bearing on each edge, about the middle, a long, stout spine which is projected outward and downward; the ends of the greater axis of the calice depressed one-third of the height; septa thin, in five cycles, the three first of which are equal and the fifth rudimentary. Alt. 13, major axis $16\frac{1}{2}$, minor 7 mil.

Princess Charlotte's Bay. It has also been found in the China Seas. Said to occur also at Moreton Bay.

Flabellum affine, *M. Edw. & H.*

Corallum adherent in its young state but becoming subsequently detached, and having a large basilar scar; very much compressed, the lateral edges being simple, slightly concave, and forming an angle of about 65°; lateral outline of the calice very convex, so that the slightly angular edges of the greater axis are

depressed about half the height; septa thin, narrow, with rather large granulations in six cycles, and the first four being equal, give them the appearance of being in 48 systems of three cycles.

Rather numerous on the N. E. coast, within the tropics, and in the Gulf of Carpentaria, at depths varying from 10 to 30 fathoms. Moreton Bay (?)

FLABELLUM CANDEANUM, *M. Edw. & H.*

Corallum moderately compressed, the lateral costæ forming an angle of about 45°, each furnished with three strong spines directed outward and downward, one near the base, the other near the centre, and the third at the edge of the calice; the ends of greater axis in a pointed arch, and very little below the plane of the short axis; columella fossa deep; septa in five cycles, but the fifth not seen in one half of the middle systems; first and second orders equal.

In the Chinese Seas, and found fossil in Australia, in the Muddy Creek, Geelong and Murray beds.

FLABELLUM DISTINCTUM, *M. Edw. & H.*

Corallum subpedicellate, but becoming free in the adult state, having scarcely any scar as the pedicel is finely pointed, where it is much compressed, lateral costæ forming rather more than a right angle; calice somewhat compressed, and the edges rising from the ends of the greater axis so as to make almost a half circle; septa in six cycles, the three first equal, giving the appearance of 24 systems composed of seven septa each. Alt. 25, major axis 33, minor 18 mil.

Japan and a Miocene fossil in Australia (Muddy Creek and Geelong.) It has been dredged at 70 fathoms on the E. coast, Cape Three Points. Dr. Rayner.

FLABELLUM RUBRUM, *Quoy & Gaimard.*

Corallum always attached, much compressed; costæ hardly distinct under the folds of the epitheca; calice deep, the summits of the lesser axis a little above the major axis, and slightly re-entering; columella (?) formed by somewhat thick and

irregular processes ; septa very thin and broad in five cycles, which by the irregularity of the three first orders have the appearance of 24 systems.

New Zealand is the habitat given by Messrs. Q. and G., at 24 fathoms, but I have seen specimens stated to have been found in Australia, but as they were in collections with N. Zealand shells I am doubtful of the habitat.

Flabellum Gambierense, *Duncan, Quart. Jour. Geol. Soc.*, 1870, *p.* 299.

Found as a fossil at Muddy Creek ; a tall, narrow, pedicellate form, curved, with long tapering pedicel, concave sides, and often small spines nearer the calice than the pedicel ; compressed epitheca, strong, in arched finely linear folds ; calice oval-elliptical ; septa in six systems of four cycles, primary and secondary equal, stout, granular, enlarged internally to form by their ends a rudimentary parietal columella ; other septa smaller and granular ; the septa are continuous with depressions between the intercostal spaces which are marked with chevron lines on the epitheca, and are in a certain sense costæ.

Height of coral about 16 mil ; diam. about half ; min. axis only slightly different. Fossil at Cape Otway.

Flabellum victoriæ, *Duncan*, loc. cit.

A small stout almost circular species with large basilar scar and two spinous processes at each side of the base like radiciform appendages. Muddy Creek and Geelong, fossil. Coral tall, compressed below, sides slightly concave, epitheca with faint markings ; angle of sides about 20° ; calice elliptical, end slightly depressed ; fossa shallow except at the centre where it is deep, narrow and long ; wall thin ; septæ delicate, not exsert, very little rounded ; granules large, unequal, and in series in six system of four cycles ; primary and secondary equal ; costæ faint, continuous with the septæ.

Flabellum duncani, *Nobis. Proc. Roy. Soc., Tasmania*, 1876, *p.* 115.

FLABELLUM IRREGULARE, N. S., Pl. 4, Fig. 2.

Corallum long, narrow, a compressed cone, attached to a shell, but the basilar attachment about half the major axis ; the summit of the calice a narrow oval, the major axis being only very slightly lower than the minor ; calice deep, with no trace of any columella; septa unequal according to the orders, not exsert, thickly covered with small granules, in six systems of five cycles, but incomplete at the two central systems ; costæ quite hidden by the dense epitheca which rises into high crests near the summit, or is marked by deep furrows on the lower part; lateral crests very irregularly furnished with long irregular spines which do not correspond on the opposite sides. Thus there is one at one side of the base, and a long curved one half way above it, but there is only a little process at the other side, and above there is another and somewhat longer. Two small *Myochama* are attached to the sides ; the septal edges do not appear to be undulating, but they have small projecting processes which, however, do not seem to unite at any part of the fossa. Alt. 25, maj. axis 18, min. $9\frac{1}{2}$, base 11, min. ax. 5 mil. Off Port Stephens, 70 fathoms.

A single specimen of this curious coral is in the Macleayan Museum. Its long narrow shape and the very irregular spines sufficiently distinguish it. No doubt some of the irregularity is caused by the adherent mollusca, but one at least must have taken its place when the coral was nearly its present size as it is high up on the cup. I have seen some specimens of what I consider is *F. pavoninum*, *Lam.*, quite as narrow and long as this species, so that mere shape could not be a sufficient distinction. But the generally neat appearance of most *Flabella* is in very strong contrast to the irregular and sordid aspect, and yellowish white color of the one described. We are not as yet sufficiently acquainted with the laws regulating the growth of spines or their use to be able to determine their specific value.

KOILOTROCHUS, GEN. NOV.

Corallum simple, free, without trace of adherence ; no epitheca; costæ simple, distinct and prominent ; columella rudimentary confined to a few papillary projections at the base of the deep and wide calicular fossa ; septa four, slightly exsert.

This genus is allied to *Ceratotrochus* and *Platytrochus*. It differs from the former in its rudimentary columella and simple small septa; from the latter in its simple costæ and septa, and from both in the extraordinary depth and width of the calicular fossa, whence the name from *Κοιλὰς*, a cavity.

There is a fossil species from Muddy Creek named by me in the *Proc. Roy. Soc., p.* 1877, *Smilotrochus vacuus*, which I think should be referred to this genus.

Genus Placotrochus, *Edw. & H.*, 1848.

Corallum simple, straight, compressed, pedicellate with a basilar scar; *columella lamellar* with a horizontal and crenulate edge; septa exsert.

Placotrochus candeanus, *D'Orbigny*.

Corallum elongate,with almost parallel lateral costæ, with rudiments of crests on the inferior half and close to the broad basilar scar two small compressed spines; calice regularly elliptical with almost horizontal edges; fossa not very deep; columella very extended; septa thin with frilled edges and very granular, in four cycles; first and second equal, third differing slightly. N.E. Australia, Princess Charlotte Bay, also found in the China seas. I believe that it extends outside the tropics.

Placotrochus elongatus, *Duncan, Quart. Jour. Geol. Soc.*, 1870, *p.* 300, *pl.* 20, *fig.* 3.

The following are the notes of Professor Duncan on this species:—"The coral is very tall in relation to its breadth, straight, greatly compressed, especially inferiorly, finely pedicellate and cuneiform. The sides are rounded and slightly swollen out here and there, and form an angle of about 15 to 20, or are sharp and slightly spined, but the spines do not project much beyond the epitheca (in old specimens); the anterior and posterior surfaces are flat; the calice is small elliptical and rounded at the sides; it has slightly exsert septa, which are rounded, thin, delicate, and unequal, and in six systems of four cycles; the fossa is central,

shallow, and long; the columella projects from the bottom of it as a distinct straight lamella, stout in the body of the coral and thinner at its free edge, is essential and marked by distinct papillæ at the junction of the septa; septa delicate, highly granular, and often wavy at the inner margin; minor axis of calice higher than the longer; costæ faintly marked, or distant and linear; epitheca in strong curved folds or in festoons between the costæ. Height from 20 to 25, length of calice 8 to 10, width 6 to 8 millim. Fossil only; common at Muddy Creek. Found at Mount Gambier, but as a cast only. Very common and large at Table Cape, Tasmania.

PLACOTROCHUS DELTOIDEUS, *Duncan.*

Coral deltoid, finely pedicellate, compressed; calice wide and long; costæ somewhat distinct; epitheca strong in arched ridges; columella long, sharp, thin, and faintly papillate; septa not exsert, feebly arched, delicate, granular, with flexuous inner margin, in six systems of five incomplete cycles; angle of sides about 60°. Alt. varying from 30 to 40 mil.; maj. axis little less than height, and minor about one-third. Very common as a fossil at Table Cape, Tasmania; less common at Muddy Creek, and River Gellibrand, Victoria, where it is also smaller.

PLACOTROCHUS ELEGANS. *Nobis. See Proc. Roy. Soc. N. S. W.*, 1877.

A very small species with coronate edge.

Family OCULINIDÆ, *Edw. & H.*, 1849.

Corallum compound, dendroid, growing by lateral buds, cœnenchyma highly developed and very compact, on which the costæ are represented by striæ or granulations; visceral chamber with few traverses but gradually filling up from below; septa few, well developed, imperforate, and without synapticula.

This family for the most part includes living species, but there are a few tertiary and secondary forms, though none older than the Oolite. There are very few Australian species.

Genus AMPHIHELIA, *Edw. & H.*, 1849.

Septa few, unequal; no pali; septal edges entire, slightly exsert; corallum dendroid; corallites alternate; columella rudimentary; costæ visible at the edge of the calice only.

AMPHIHELIA VENUSTA, *Edw. & H.*

Branches tending to develope on the same vertical plane; calices alternate: short costal grooves in the neighbourhood of the calices, which are deep and without a columella; septa in three cycles, a little exsert, thickened exteriorly, a little bent, unequal according to the orders, but sometimes in the same order; tertiaries rudimentary. Width of calices 3 millim.

Not uncommon in many places on the east coast at moderate depths, from 10 fathoms.

AMPHIHELIA INCRUSTANS, *Duncan, Quart. Jour. Geol. Soc.*, 1870.

Corallum flat, encrusting; calices arising like crateriform processes; surface irregular, with undulating, subequal, bifurcating costæ passing more or less obliquely to the outside of the calice; calices very minute, crateriform; margins sharp; fossa shallow; septa in six systems of three cycles with the rudiments of a fourth, not exsert, and smaller than costæ; columella small and projecting.

Professor Duncan proposes to place the genus *Amphihelia* amongst the Turbinolidæ, because the calices do not fill up from below, and the visceral chamber is quite free. It remains to be seen if this arrangement will be accepted. With so highly developed a cœnenchyma, and a dendroid growth, the genus would certainly be an anomalous one amongst the Turbinolidæ, while its connexion with other Oculinidæ seems in all but the absence of endotheca to be most natural. I have, however, in my possession a fossil from Aldinga, in which some of the calices on the same branch fill up from below, and some are quite empty to the base of the fossa. This fossil will be figured and described shortly.

Genus STYLASTER, *Gray*, 1831.

Corallum dendroid, alternately but somewhat irregularly budding; cœnenchyma highly developed with occasional little points or vesicular tubercles; columella styliform, placed deeply in the visceral chamber; septa equal, not projecting much, imperfectly developed and few.

STYLASTER GRACILIS, *Edw. & H.*

Corallum fan-shaped; branches fitted somewhat closely, packed but not coalescent, of a rose orange, with the exceptions of the last ramifications, which are white; the main trunk has a smooth surface; the branches have microscopic striæ, and are all covered with subspinous tubercles; the calices in an opposite vertical series on both sides of the branches in general somewhat projecting; 12 to 13 rather thin septa, which are very exsert in the terminal calices. None of them exceed $\frac{2}{3}$ millim. in diameter.

Not common on the east coast, north of Botany Bay.

STYLASTER SANGUINEUS, *Valenciennes.*

Corallum subflabelliform, the principal branches almost white, the thinnest of an intense blood red; vescicular tubercles gathered in small groups presenting radiated costæ, and separated by little pits; calices the same as the last, but some scattered on the surface of the branches, somewhat projecting. $\frac{2}{3}$ millim. in diameter and with 12 septa.

Rather uncommon on the east coast.

STYLASTER GRANULOSUS, *Edw. & H.*

Branches irregular, of a rose purple, the surface covered with very distinct papilliform granules; tubercles small, few, radiately costulate, slightly projecting; calices on the surface of the branches scattered, circular or oblong, with indistinct margins. 1 millim. wide.

The habitat of this species is given as Australia, but I don't remember to have seen anything like it, except an imperfect fragment which came from Port Stephens.

Fam. Astreidæ. *Dana*, 1846.

Corallum compound, tissue imperforate or almost so, interseptal chambers divided by traverses which are disconnected with those of other chambers so as not to form floors; this endotheca gives the lower part of the visceral chamber a cellular structure which, however, is never developed into a compact tissue; septa more or less imperfect on the outer edge, but never perforate throughout; no cœnenchyma; the walls of the calices being united to one another or confluent by means of the costæ, which have also intercostal traverses. Sometimes there is a false cœnenchyma (peritheca) formed by traverses between the walls of contiguous calices.

Some little connection exists between this family and Turbinolidæ in such genera a *Cœlosmilia*, *Lophosmilia*, and *Conosmilia*, in which the endotheca is rudimentary; but all the family have *transverse interseptal subdivisions*. It is divided into two subfamilies, viz:—*Eusmilinæ* or *Astreæ* with entire and sharp edges to the septa, and *Astræinæ* with septal edges divided or spinous.

These again are subdivided into—1st, *Trochosmiliaceæ*, or those which have the corallum simple; 2nd, *Euphylliaceæ*, or those which are compound, but multiplying by fissiparity; 3rd, *Stylinaceæ*, compound and multiplying by budding.

Sub. family Eusmilinæ. *First Div.* Trochosmiliaceæ.

Genus Consomilia. *Duncan*, 1870.

Corallum simple, pedicellate, conical; columella of one or more twisted laminæ which extend from the base upwards; endotheca scantily developed; septa with apparently simple margins and variable with regard to the number of primaries.

Of these corals Prof. Duncan says that they are the most interesting our tertiary beds possess, having a curious union of abnormal peculiarities. "A simple coral with pellicular epitheca, having a beautiful herring-bone ornamentation, with an essential twisted serialaire columella with endothecal dissepiments and with plain septa which have the hexameral arrangement in some,

and the octameral in others, is a form containing the elements of several classificatory systems." *Dunc. in Quart. Jour. Geol. Soc.*, 1876, p. 309.

I have already given in the *Proc. Roy. Soc.* of N. S. W., for 1877, a synopsis of the genus which includes only fossil species. They are *C. elegans*, *C. anomala*, *C. striatula*, *C. lituolus*, all described by Duncan as above, and *C. bicyla*, *nobis. loc. cit.*

Second Div. EUPHYLLIACEÆ.

Genus EUPHYLLIA. *Dana*, 1846. (*pars*).

Corallum tufted or subfoliaceous, the base developing very little with age; the corallites in multiplying become free above, or remain united in a more or less lengthy series, but then this series is always free in the costæ and the calicinal centres which are always distinct; there is no trace of a columella; septa very numerous, excessively thin, bare, almost smooth below, and costulate in the vicinity of the calice; endothecal traverses abundant though the septal chambers are somewhat deep.

EUPHYLLIA GLABRESCENS. *Chamisso.*

This is strictly a tropical species which Prof. Duncan gives in his list as Australian. It is not, however, known in this country. Milne Edwards describes it as coming from Raddak Island, Australia. There is no such island off Australia, but probably the island of that name which is one of Marshall's group, in Polynesia, is meant.

Second sub-family, ASTREINÆ.

Turning now to the second sub-family of ASTREIDÆ, that is, of those which have septa deeply lobed or furnished with spines, we find them divided into two sections. 1, *Lithophylliaceæ* or *Astreæ* which are simple corals or increasing by fissiparity the corallites disposed in crested tufts or in linear more or less confluent series. 2, *Astræaceæ*, which are massive compound corals multiplying by budding and never serial. There is an inter-

mediate sub-division called *Faviaceæ*, where the corallites multiply by successive fissiparity, but are soon individualized and are grouped without order in a massive coral.

Among the simple LITHOPHYLLIACEÆ, (*Mussaceæ*) we have one which Prof. Duncan has referred to his genus *Antillia*. It is a discoid form whereas in the definition of the genus, (*Quart. Jour. Geol. Soc. Vol.* 20, *p.* 28), it is said the coral is short, turbinate, and pedicellate. I subjoin the Professor's definition of the species which is a fossil, but as I have met another species it may be desirable to separate the discoid forms into a distinct genus.

ANTILLIA LENS, *Duncan.*

Coral is the shape of a Cyclolite (*Fungidæ*); the base is circular in outline, nearly flat, the concavity being very slight; the epitheca is pellicular and faint; the costæ are seen as radiating flat elevations, those corresponding to the smallest septa being the smallest; the margin of the base presents slightly exsert equal processes, which are the septa; the upper surface of the coral is convex and nearly hemispherical, the depression for a small essential columella, formed by processes from the base and septal ends being slight; the septa are in six systems of four cycles; the primary and secondary septa are equal, and the tertiary are nearly as large; those of the fourth and fifth orders are somewhat less; all are very convex superiorly, and less so and nearly straight externally; the laminae are thin, and are very strongly marked by sharp ridges, which radiating from the basal part of each septum are more or less parallel, and give at the free margin a laterally dentate appearance; this appearance is less marked in the smaller septa; there is often a paliform process on the larger septa, near the columella, and the terminations of the ridges give the dentate character to the free margin of the septa; the endotheca is scanty, stout, and inclined. Breadth $\frac{3}{10}$ inch, height $\frac{2}{10}$ inch.

Locality Hamilton, Victoria, S. Australia.

Genus Homophyllia, *Bruggemann*, 1877, *Ann. Nat. Hist.*, 1877, *Vol.* 20, *p.* 310.

Coral neatly turbinate, with a narrow somewhat expanded base ; outside of wall covered almost to the edge with a thin, closely adherent epitheca, through which the costæ are distinctly perceptible; costæ crowded, perfectly equal, prominent, minutely denticulate ; calice circular, deep ; septal edges crowded with narrow subequal teeth; columella very small, rounded in outline, closely tubercular.

The author remarks of this genus that it is established for the reception of *Caryophyllia australis* of Milne Edwards. It is distinguished by its scanty endotheca, which makes the calice deep, and the structure of the costæ and septa. He observes that if these peculiarities would not justify generic separation it would be necessary to unite all the simple *Mussaceæ* into one genus.

Homophyllia australis, *Edw. & H. (as Caryophyllia.)*

Septa moderately prominent, rather thin, uniform in thickness, scabrous from small pointed granules ; systems quite distinct in six cycles, the last incomplete, primary and secondary equal ; teeth much crowded, middle-sized, narrow, straight, rather obtuse, those in the middle generally longest, decreasing towards circumference and centre ; tertiaries narrow, with fewer and longer teeth, fourth cycle similar and not reaching the columella, fifth and sixth cycle half as long and scarcely dentate; columella much reduced and low, surface subpapillose. Very young specimens, 4 to 8 mil. in diameter, are broadly attached and very shortly cylindrical, almost discoid, epitheca present from the beginning. Adult 20 mil. alt., diameter of calice as much as 30.

Hab. Port Lincoln, Australia, and Chinese Seas ?

" M. Edwards (says Dr. Bruggeman) has mistaken this coral for the young of a West Indian *Isophyllia ;* the description of *Isophyllia australis* (*Hist. Nat. Cor., vol.* 2, *p.* 375) has nothing to do with the species under consideration. The latter is found growing socially on rocks, and occasionally it happens that two

neighbouring specimens touching each other become intimately united by their walls. This spurious compoundness is caused by contact and not by fissiparity. There can be no doubt that *Homophyllia* remains solitary at all ages."

It occurs to me that there is a close relation between the genus thus described and *Cylicia* of the Astrangiaceæ, of which already three species are described from South Australia.

Third Division *Astræacea* or *Astræa* which have a massive corallum whose corallites intimately united by their costæ or walls multiply essentially by budding, the individuals being distinct from their origin though sometimes budding in another calice or near the central fossa, thus giving rise to a kind of false linear arrangement.

Genus CYPHASTRÆA, *Ed. & H.*, 1848.

Corallum a convex and gibbous mass broadly adherent; costæ and exotheca much developed and forming a compact and very dense tissue with a granular or hispid surface; edges of calices free and round; columella papillose, conspicuous; septa very exsert, narrow; laminæ at the wall and divided into processes in their internal moiety, with fine teeth which are largest near the columella; budding extra-calicinal. The very compact structure at the muro-costal region, and the lax open tissue at the central region easily distinguish this genus. The species are all small.

CYPHASTRÆA MICROPTHALMA, *Lamarck* (*Animal. s. vert.*, 2*nd ed. t.* 2, *p.* 408.)

Corallum gibbous, calices close, circular, salient; costæ slightly so; interstices strongly granular; columella papillose; two cycles with a third in two or four systems in which the secondaries equal the primaries, so that there are in appearance 8 to 10 simple systems; septa slightly exsert, thick at the wall, thin within, toothed with a little paliform tooth near the columella; in section it is seen that the wall and exothecal dissepiments are thick and horizontal, but often lost in the general compactness of the tissue; septa deeply divided into three long and ascending teeth; endothecal dissepiments very thin, simple, close and hardly sloping. Calices $1\frac{1}{2}$ mil. in diameter.

CYPHASTRÆA MUELLERI, *Ed. & H.*

Less hispid than the preceding; columella rudimentary, septa unequal and exsert, probably only a variety.

Both the above species are probably found on the S. E. coast, near Port Jackson, though I have no well-authenticated habitat.

Genus PLESIASTRÆA. *Ed. & H.*, 1846.

Corallum a convex mass, rising from a costulate plateau; calices shallow, circular, edges free; columella spongy; costæ and exotheca well developed; septa exsert, stout, continuous, and denticulate; *pali well developed* before all the septa except the last, budding always in the intercalicular spaces. The genus distinguished from all the Astreacæa with free calicular margins by the presence of pali.

PLESIASTRÆA URVILLEI. *Ed. & H. Syn. Astrea galaxea. Quoy & Gaimard. Voy. de l'Astrolabe, Zooph. p.* 216, *pl.* 17, *f.* 10-14.

Corallum somewhat flat with sub-lobed edges; epitheca on the edges rudimentary; calices very slightly salient, close but distinct, circular or sometimes a little deformed; columella rudimentary; three cycles, but a fourth in two systems where the primary equal the secondary, thus giving the appearance of eight systems of three; septa rather broad, hardly exsert, thin, finely and regularly dentate, striate, and granular; pali broad, little exsert, rather thin, the primaries the strongest. In section the exothecal dissepiments are almost horizontal, 1 mil. apart; columella of a very lax tissue, scanty and formed of lamellar processes; endothecal dissepiments extremely thin, sometimes wavy, not always parallel, sloping inwardly, $\frac{3}{4}$ mil. apart; wall compact, rather thick, seldom or only slightly united to others. Diam. of cal. 4 to 5 mil. In shallow places King George's Sound. Messrs. Q. and G. say that the animal is confluent and of a beautiful grass green.

PLESIASTRÆA PERONII. *Ed. & H.*

A gibbous corallum; calices unequal, from 3 to 5 mil. in diam., close, unequally salient, edges very distinct, generally circular; three cycles complete, rarely a few septa of a fourth; septa strong, feebly denticulate, slightly exsert, very unequal according to the orders. Common from Port Stephens southwards on the E. coast through Bass Straits.

Division ASTRANGIACEÆ.

This is a fifth group of the *Astræa*, established by Messrs. Edwards and Haime, to receive those forms which multiply by buds on a basilar expansion and whose corallum is always very short and creeping.

Genus CYLICIA. *Ed. & H.*, 1851.

Corallum spread over submarine bodies composed of coralites altogether independant of one another but grouped together; they are produced by budding on a base which does not harden; they are largely adherent, extremely short, subcylindrical, a little oblique and surrounded by a complete epitheca; calices subcircular, excavated, and deep; septa thin, rather close, not exsert, the principal have a subentire edge, the others very deeply toothed; columella papillary and well developed.

When these corals are found dead the connecting expansion has disappeared and they look like a close association of numerous calices irregularly scattered over the rock and encrusted with *Polyzoa*.

CYLICIA RUBEOLA. *Quoy and Gaimard, (as Dendrophyllia). Voy. Zooph. p.* 97, *pl.* 15, *f.* 12-15. *Angia rubeola. Ed. & H., Ann. Sci. Nat.*

Corallites very short, a little inclined; epitheca projecting as a thin entire edge; calices circular or subcircular; fossa wide and deep; columella well developed, formed by the styliform lobes of septa or undistinguishable from them, they gradually lengthen towards the edge; three cycles in six systems, but the third wanting in two systems, giving the appearance of five ternary

systems ; septa very thin, rather close, finely granular, primaries broad and subentire for half the length and then like all the others deeply lobed into styliform processes ; tertiaries bent towards the secondaries and uniting with them close to the columella. Alt. 5, diam. 4, depth of calice 4.

The original species of this pretty coral came from the Thames River, N. Zealand. Another species named *C. Verreauxi*, Ed. & H., was described as from New Holland. This differs from the foregoing in having the three cycles complete in all the systems with the rudiments of a fourth. Prof. Tate has sent me specimens from Port Adelaide, which bridge over the differences between the species as there are the rudiments of a fourth cycle, and the systems are not complete, and some specimens from King's Island have the systems complete but with only three cycles. All the specimens I have met are united by polyzoa (*Cellepora* and *Lepralia)* and their cellular structure in fragments at the base of the calices might easily mislead one into the notion that there was a reticulate cœnenchyma.

Cycilia tenella is said to come from Australia, but Messrs. Ed. and H. refer it to the Cape. It is distinguished by its inconspicuous columella and three complete cycles.

Cylicia Smithii, also referred to Australia has a finely granular epitheca, well developed papillary columella, and four complete cycles ; the calice is very shallow. I have not seen either of these two species. Prof. Duncan refers all, except the first species, to the Cape. There is evidently some confusion about both the species and the habitats which I have not been able to clear up.

CYLICIA MAGNA. N. S. Pl. 4, Fig. 3, a, b, c.

Corallum large, broadly and obliquely turbinate, and largely adherent ; epitheca very solid in rugged concentric folds through openings of which the slender close costæ are seen at intervals ; calice roughly circular, either open and shallow or narrow and deep ; septa of five cycles in six systems all complete except in young individuals where the higher orders are rudimentary in some systems, not exsert, but sloping away from the epitheca,

which slightly overlaps the edge of the wall; primaries and secondaries equal in thickness and reaching the columella; tertiaries very nearly reaching it; fourth and fifth orders very thin towards the centre, but reaching fully two-thirds of the distance to the centre; fifth cycle very thin and small and reaching about a fourth of the distance or even less. All orders entire for a fourth of their length, and undulating, then deeply and narrowly lobed, the fourth cycle dividing into narrow, tall, styliform processes; all very granular; columella very little prominent and consisting of a few broad and irregular granular lobes quite at the bottom of the calice, easily distinguished from the septal lobes being more closely granular and of more solid form; endotheca confined to a very few dissepiments between the higher orders and primaries near the edge of the calice; costæ (where visible through the incomplete epitheca) quite laminar, corresponding to the septa and slightly lobed, intercostal spaces deep, exotheca rather abundant in horizontal or curved and inclined dissepiments. Alt. 12 to 15, lower edge a third less; diam. of calice 13 to 17, millim. Depth about $\frac{2}{3}$ of alt.

St. Vincent's Gulf, S. A. These specimens were sent to me by Prof. Tate, F.G.S., who has not recorded anything of the stolon or mode of increase, but I have no doubt that they should be referred to the Astrangiaceæ, though from the definition of Dr. Bruggeman's genus *Homophyllia*, it does not seem easy to distinguish from descriptions alone, what that learned author most relies upon as generic and specific in character. Perhaps it would be better to remark that the septa in his genus are exsert, and the teeth never become separate lobes. Of course this is supposing there is no means of ascertaining the presence or absence of a stolon.

Cylicia quinaria, n. s. Pl. 5, Figs. 3, a, b, c, d, e.

Corallum cylindrical, adherent by its entire breadth; height equalling or exceeding the diameter; costæ, when present, thin, with styliform lobes, and not corresponding with any of the cycles, but quite irregular and separated by wide, smooth, inter-

costal spaces, not very salient, but from about the middle downward developing into long buttresses which are adherent to the support; calice circular, deep, margin in one plane or very slightly inclined; septa not exsert, but sunken, in *five* systems of four cycles complete in each system; they are close, thin, the three first nearly equal, irregularly lobed and granular, the third orders often, the 4th and 5th always represented by a series of oblique styliform projections from the wall; primaries and secondaries descending perpendicularly; in the centre two or three styliform processes quite similar to the lobes of the septa from the columella. Alt. 6, diam. from 3 to 6 millim.

This singular coral which is referred to the genus *Cylicia*, was found amongst the collections of the late W. S. Macleay, with no locality indicated. But as all the specimens, about 15 in number, were encrusting a small piece of sandstone of the kind found at Port Jackson, and as there were many species of Polyzoa upon the stone, such as are living in the same place, I have very little doubt that the specimens came from somewhere near Sydney Harbor. Among all the specimens only one of them showed the remarkable buttress-like ribs. This gave it a resemblance to the British *Paracyathus pteropus*, Gosse. Even in this case they were only on half the corallum. The rest of the specimens were so encrusted with Polyzoa, (chiefly *Lepralia)* that these interesting organs could not be made out on them. It is further worthy of remark that the costæ though not corresponding with any of the septa were lobed like them; the styliform character of the higher orders of septa made their separation from the columella difficult, if not merely arbitrary.

Fifth Family of Madeporaria aporosa.— Fungidæ.

In the previous groups we have been dealing with families in which the interseptal spaces were open throughout, *(Turbinolidæ, Dasmidæ)* or were crossed at regular distances by lamellar traverses *(Oculinidæ, Astreidæ)*. The *Fungidæ* have a different character which is that the lateral faces of the septa develope bosses or tubercles which approach the opposite septum and a

fastened to it so that the visceral chambers are traversed by bars or barriers, often of considerable extent and height, but never completely closed by them. These organs are called *Synapticulæ*. They are generally accompanied in most of the family by vertical or slightly oblique ridges of compact sclerenchymatous tissue on the faces of the septa from which the synapticulæ arise. This tissue is sometimes continuous and equal, but sometimes it is interrupted at regular intervals. The *Fungidæ* are divided into two subfamilies: 1, *Funginæ*, with the wall or common plateau porous and generally roughly tubercular or subspinous; 2, *Lophosorinæ*, with the wall neither perforate nor tubercular.

In the first division of this family we have none of the genera in extratropical Australia. *Polyphyllia pelvis*, is said by Messrs. Quoy and Gaimard to occur in New Zealand, which is very singular as we have no *Fungidæ* in similar latitudes on the Australian coasts. The genera *Fungia* and *Polyphyllia* are both very well represented in N.E. tropical Australia, and I believe most of the Pacific species are found in the Barrier Reefs.

In the second division we have two species, but only found within a very few degrees of the tropics and scarcely straying outside them; they are both in the genus *Cycloseris*.

Genus Cycloseris. *M. Ed. & H.*, 1849.

Corallum discoid, simple, without a trace of adherence; wall horizontal with finely granular numerous costæ and no epitheca; septa very numerous, (5 to 8 cycles) the smaller united to the larger by the thin inner edge and the superior edge of all finely serrated.

Cycloseris cyclolites. *Lamarck.*

Corallum an ellipsoid, thick, and rising in the centre to a height of about half the major axis, concave beneath, where it is granular in the centre; costæ numerous, close, fine, in cycles, the higher orders smaller and arising near the edge when they are prolonged and lamellar; central fossa narrow, deep, generally extended in the direction of the major axis; seven to eight cycles the last not present in all the systems; septa elevated, the three first orders

thicker internally and often united to the smaller for a great part of their surface, granular in radiate lines; very numerous and giving the edges of the septa quite a mossy aspect; columella and papillæ at the bottom of the fossa; synapticulæ numerous but not easily seen as the septa are so close. Long. 50, lat. 35, alt. 25 millim.

Lady Eliot's Island, Harvey's Bay, (lat. between 27 and 26), and so up to the Barrier Reef, though rare. Common in New Caledonia.

Cycloseris sinensis. *M. Ed. & H.*

Corallum nearly circular, very thin, slightly exsert, and a little concave beneath; costæ in cycles but very uniform in size, close, very small, the higher orders and a small part of the centre being only a series of granules; fossa open, more or less extended in a line of the slightly longer major axis; columella conspicuous; a crowded mass of long almost circular papillæ; septa in eight cycles not always complete in some of the systems, the higher orders of the last being wanting or rudimentary; all very thin, very granular, the primaries and secondaries being just a shade thicker and more raised at the fossa; edges not serrated but irregular; synapticulæ irregular, not numerous, solid; granules subspinous and giving the laminæ a mossy appearance as seen from above; the septa of the higher orders are often fenestrated and often unite by their inner edge to the older. At their base, the synapticulæ appear as solid ridges. Diam. from 20 to 30, alt. 5 to 8 mill. Scarcely 2 millimetres difference between the major and minor axis. Localities same as preceding. Very common at Darnley Island. Rare outside the tropics.

Cycloseris tenuis. *Duncan.*

Corallum circular and very thin, slightly convex in the centre; fossa shallow, elongate; concave below with numerous costæ; septa distinct, distant, slightly dentate, in six systems of five cycles. Diam. 12, alt. 6 mil. River Gellibrand, Victoria. Fossil only. Prof. Duncan's definition is somewhat brief. The five cycles, however, sufficiently distinguish the species.

Genus Palæoseris. *Duncan*, 1870.

This genus was founded by Prof. Duncan for a fossil which he had formerly described as *Trochoseris Woodsi*, but a minute examination induced him to place it among the *Lophoserinæ* as it was found to possess synapticulæ.

The corallum is simple, turbinate, and pedicellate; septa numerous; columella rudimentary; epitheca complete, dense, covering costæ.

Palæoseris woodsi, *Duncan*.

Corallum with small pedicel, cylindrical, conical, turbinate; calice wide, circular, shallow, margin thin; septa delicate, crowded, subequal, not exsert; six systems and five cycles with half of a sixth in each system; smaller septa generally joining the larger which reach the central fossula; laminæ marked laterally by synapticulæ. Alt. 16, lat. 13 mil. Muddy Creek.

Mæandroseris australiæ, *L. Rousseau*, 1854, and *Favia Bowerbankii*, Val. are species which I believe belong to the tropical regions of Australia, amid the islands of the great Barrier Reef, though cited simply as from Australia by authors. To these must also be added *Prionastræa australiensis*, and *Merulina ramosa*. *Echinopora rosularia*, Lamarck, is a reef-building form which is cited as coming from "*Terre de Van Dieman.*" From this circumstance it has been attributed to Tasmania. It must be, however, that the Terre de Van Dieman in North Australia is meant, because no such coral is known outside the tropics in Australia, and therefore certainly not in Tasmania, formerly known as Van Dieman's Land. As far as I can gather, the term Terre de Van Dieman as applied to part of North Australia, is only used by old French geographers. It is thus distinguished on the map prefixed to the work of De Brosses. The coral occurs at the Seychelles and Feejee. I have also seen specimens from the northern parts of the Barrier Reef. *Rhodarœa calicularis*, Lamarck, is another tropical reef-building form which is cited generally as from Australia. It is a *Porites* without a columella.

Genus LOPHOSERIS, *M. Ed. & H.*, 1849.

Corallum compound, adherent, foliaceous in crests or irregular lobes, covered with radiate and confluent calices; columella tuberculous and sometimes rudimentary; the common surface destitute of epitheca and finely striate. The very thin expansions of this coral with calices on generally both sides distinguish it from all the other Fungidæ.

LOPHOSERIS CRISTATA. *Ellis & Solander.*

Corallum in a tuft of erect crested thin expansions with calices on both surfaces; the expansions are much thinner in the edges, are raised and coalesce with many vertical ridges; calices close, and the septacostal rays elongated; fossa distinct and somewhat deep; columella a little tubercle or absent; septa in three cycles the last wanting in one or two systems; secondaries nearly equalling primaries; tertiary very thin all slightly toothed at the edge and somewhat granular, principally developed vertically though a little bent; calices about 3 millim.

Manly Beach, Port Stephens, The Solitaries, Cape Byron, Moreton Bay.

LOPHOSERIS FRONDIFERA. *Lamarck.*

This species has the calices a little smaller than the last, with 16 to 18 very thin septa, close, alternately exsert, and scarcely serrated; the corallum is very small. If I am correct in my identification this is not very uncommon on the coasts of Queensland as far south of the tropics as Wide Bay.

Second order, MADREPORARIA PERFORATA. Corals formed almost entirely of porous or reticulated cœnenchyma; septa very distinct in character, composed primarily of six elements, but sometimes represented by a series of little bars or processes; transverse divisions, rudimentary, never forming floors or tabulæ; the wall which constitutes the greater portion is always perforated and does not develope costal laminæ; visceral chamber open from the base to the summit, and has neither traverses nor synapticulæ nor floors; there are two divisions in this section: 1st, *Madreporidæ*; mural system well developed and simply porous;

principal septa slightly, or not perforate; 2nd, *Poritidæ*; entirely composed of reticular sclerenchyma; septa represented by little bars or processes.

The Madreporidæ are again subdivided into three families: 1. *Eupsammincæ;* no independant cœnenchyma. 2. *Madreporinæ;* cœnenchyma abundant, six principal septa, two of which are much greater than the rest. 3. *Turbinarinæ;* septa six, equally developed.

First Fam., EUPSAMMINÆ.

Septa well developed and forming many cycles; primaries equal but the last cycle bent towards the preceding order, so that the calice has not the radiate appearance of most corals; wall formed of distant vertical sclerenchymatous nodules, united only at their points of contact so as to leave perforations which occasionally become obliterated below only. They are simple or compound corals; the corallites nearly always cylindro-conical without exotheca or peritheca; wall feebly costulate, scarcely ever with a complete epitheca,* the tissue being shagreened or velvetty in aspect; cycles 4, 5, rarely the rudiments of a 6th; the last cycle of whatever number, never forms straight rays but bent according to a simple law, thus:—If it be of four cycles, the fourth order diverges from the primary, and the fifth order from the secondary, until they meet or nearly meet in front of the tertiary, with which they are intimately united below. If there are five cycles it is the 6th, 7th, 8th, and 9th orders which diverge. Each half of the system will then resemble an entire system of four cycles; on one side the 6th system diverges from its adjoining primary, and the 8th from the tertiary, to unite together, and with the fourth which is between them; on the other side the 7th diverges from the secondary, and the 9th from the tertiary, to unite with the 5th which they bound on the left and right. Sometimes the penultimate bends towards the tertiaries and the tertiaries towards the secondaries, so that the primary alone is free; this peculiarity though always present is feebly manifest in some genera such as *Leptopsammia*, *Endopsammia*, and *Dendro-*

* *Dendrophyllia epithecata.* Duncan, a fossil of Tasmania, is a solitary exception.

phyllia, the last cycle is always more developed than the immediately preceding, to which also the same genera are an exception; the higher orders are also reticulate or incomplete in their tissue so as to be perforated or honeycombed; there is always a columella (except in some species of *Stereopsammia*), and it is of spongy texture.

Genus ENDOPACHYS, *Lonsdale*, 1845.

Corallum simple, straight, much compressed below; no trace of adherance; base keeled or with aliform appendages; costæ distinct, straight, formed by series of granules; columella little developed; septa exsert and granular; only two species hitherto known; one living, habitat unknown; and an Eocene fossil from Alabama, N. America.

ENDOPACHYS AUSTRALIÆ. N. S. Pl. 6, fig. 1, a, b, c.

Corallum elegantly cuneiform, somewhat tumid until close to the base, where it becomes much compressed; the edges of the major axis slope away from the summit until about two-thirds of the whole length and then suddenly bend towards a very fine point, leaving two somewhat aliform obtuse angles; the sides of the minor axis are convex but slightly more on one side than another; costæ finely granular, distinct, raised, rounded, corresponding to the septa; a few of the higher orders uniting with older at the compressed part, and the outer ones becoming curved round and ceasing at the alæ, the rest gradually tapering and continuous to the basilar point; interseptal spaces narrower than the costæ and perforated; calice broadly elliptical, the ends of the major axis being a little lower than the rounded minor axis on which the septa make conspicuous projections; septa spinously granular, in six systems of four cycles; first and second conspicuously exsert; the fourth and fifth uniting with the third order about half way, and these again uniting with the secondaries close to the columella so that the primaries are alone free; all uniting with the columella which is reduced to a thin open almost laminar tissue. There are rudiments of a fifth cycle in the four systems at the end of the major axis, and here also the septa are crowded and irregular. Wall very conspicuous though thin. Alt. 15, maj. axis 13, min. 10 mill. Off Port Jackson, 80 fathoms.

Genus Balanophyllia, *Searles Wood*, 1844.

Corallum simple, fixed by a large base or pedicellate, more porous than Dendrophyllia ; no costal appendices ; costæ fine, close, subequal ; columella well developed, but never projecting from the bottom of the calicular fossa ; septa thin, close, the last cycle well developed and complete ; the distinct costæ and the complete development distinguish this genus, which is well represented both as a living and fossil form in Europe. In our Australian tertiaries it had a large development, but so far, I am only acquainted with one living species in our seas.

Balanophyllia buccina, n. s. Pl. 5, figs. 5, a, b, c, d, & Pl. 4, fig. 5.

Corallum narrowly pedicellate and generally clasping a small shell, subcylindrical or compressed : broad at the summit and rapidly tapering, rarely straight, nearly always curved in the direction of the shorter axis ; calice elliptical, lower at the ends of the longer axis ; epitheca moderately developed, extending about half way up the calice, or appearing in a series of very undulating, disconnected, concentric rings, which are thick, projecting, and corrugated ; costæ in series of scattered granules, and sometimes hardly traceable under a uniform worm-eaten appearance ; the wall is very open and honeycombed ; fossa one-third the depth of the whole corallum, and having a broad flaring appearance ; columella very loosely spongy and rather broad ; septa slightly exsert, granular and porous, the higher orders almost as loosely reticulate as the columella, in six systems of five cycles, the sixth and eighth orders uniting in front of the fourth, and the seventh and ninth in front of the 5th, close to the wall, and both the laminæ thus formed again uniting in front of the third at or close to the columella ; primaries and secondaries free, evenly rounded, 6th order the most developed and very thick and jagged at the columella. Fully developed specimens, 25 to 30, major axis 18 to 23, minor axis 11 to 14, mil. In smaller specimens only four cycles ; costæ very distinct, epitheca faint, in pellicular translucent rings near base. Two young specimens, sometimes cemented together.

Cape Three Points and off Port Stephens, 70 fathoms. Worn specimens sometimes washed up at Manly Beach and Wollongong. Always attached to shells (*Bittium*, *Turritella*, and small *Mitræ*) except when the pedicel was broken. A species very distinct from any of our tertiary fossils. Its broad and solid cup and generally curved form are very characteristic.

It will be remarked that I have figured one of the specimens with a conspicuous boss on the side. This may be a *bud*, and if so the species will have to be transferred to *Dendrophyllia*. The general character of the corallum and the septa is not in favor of such a conclusion.

BALANOPHYLLIA SEMINUDA, *Duncan*.

The corallum has a wide base with a constriction immediately above it, and is cylindrical, but slightly wider at the calice than elsewhere; the epitheca is very dense for half the distance up the corallum and is wanting elsewhere; the costæ, invisible below, are distinct where the epitheca does not exist above; they are formed by vermiculate projections.; the calice is circular in outline; its margin is thin, except at the origin of the primary and secondary septa, where it is thick and cellular, and its fossa is very deep; the septa are unequal, exsert, curved above, and more or less vertical at their inner edge; they are marked with ridges, which are directed inwards and upwards, and with endothecal ridges crossing the first kind; the primary septa are stout and very exsert, and the secondary septa are smaller and less prominent; the tertiary septa, after their union with those of the fourth cycle are very stout and reach the columella; the septa of the fourth and fifth orders join the tertiary about half way to the columella; the columella is small and spongy, and is situated very deeply in the fossa. Height of the corallum 8-10 inch, breadth of the calice 3-10 inch.

Locality: Hamilton Tertiaries, Victoria.

BALANOPHYLLIA ARMATA, *Duncan*.

The corallum is subcylindrical, tall, compressed, and armed with a wing-like projection immediately above either side of the

base; the base is moderately large, and presents evidences of attachment to some substance during life; there is a slight constriction above the base; the epitheca is imperfect, and surrounds the corallum here and there in many lines; the costæ are distinct, wide, equal, and covered with spiny granulations; they are more or less continued over the small lateral wing-like projections; the calice is elliptical in its outline, shallow, and with a sharp, narrow, and slightly cellular margin; the columella is large, long, and spongy; the septa are unequal, not exsert, stout and granular; there are four cycles of septa in six systems; the septa of the first, second and third orders reach the columella, and those of the higher curve towards and meet the tertiary midway between the wall and the columella. Height of corallum 1 2-10th inch, breadth of calice $\frac{1}{2}$ inch.

Locality: Hamilton Tertiaries, Victoria.

Balanophyllia selwyni, *Duncan.*

The corallum is subcylindrical and slightly compressed, and has a large base with a slight constriction above it; the costæ are distinct, flat above and rounded midway, and below finely granular superiorly, and marked with one series of large granules inferiorly; the epitheca is absent; the wall is moderately developed; the columella is large and long; the septa are very stout; there are four cycles of septa, in six systems, and the higher orders unite with the tertiary at about one-fourth of the distance from the wall to the columella; the calice is compressed and elliptical. Height 1 inch, greatest length of the calice $\frac{1}{3}$ inch.

Locality: No. 3, upper coralline beds, near C. Otway, Victoria.

Balanophyllia fragilis, *Duncan.*

The corallum is long and conico-cylindrical in shape, twisted and curved; the epitheca is quite rudimentary, in the form of slight transverse bands; the costæ are flat and marked with one series of small, distinct, sharp, spiny granules, or with a ridge; the wall is very thin and hardly cellular; the columella is very

small; the septa are plain, long, slender, and irregular; the higher orders unite with the tertiary close to the wall; there are four cycles in six systems, the fifth order being occasionly absent; the endotheca is tolerably developed. Height of corallum, $\frac{3}{4}$ inch; length of calice, $\frac{1}{4}$ inch. Locality: Muddy Creek, Hamilton Tertiaries, Victoria.

BALANOPHYLLIA AUSTRALIENSIS, *Duncan.*

The corallum is pedicellate, long, cylindrical, tapering and curved; the calice is elliptical; the fossa is shallow; the septa are not exsert, are thin, marked with arched ridges; and there are four cycles in six systems, with a very few laminæ of a fifth cycle; the higher orders unite with the tertiary close to the wall which is very thin; the columella is large; the epitheca is scanty, and surrounds the corallum at certain parts only; the costæ are vermiculate, and slightly spinous. Height of corallum, $1\frac{1}{2}$ inch; length of calice, $\frac{4}{10}$ inch. Locality: Muddy Creek, Hamilton Tertiaries, Victoria.

BALANOPHYLLIA CYLINDRICA, *Michel, sp. Var. A.*

The corallum is cylindro-turbinate and curved at the base, which is not pedicellate but sharp; the calice is large, shallow, and very open; the epitheca is complete and covers the faintly distinguishable costæ; the wall is moderately stout and cellular; the columella is moderately developed; the septa are stout; and there are four cycles in six systems; the higher orders unite with the tertiary about midway. Height of corallum, $\frac{7}{10}$ inch; breadth of calice, $\frac{4}{10}$ inch. Locality, No. 1, $1\frac{1}{2}$ mile west of Cape Otway. Variety B. Corallum more slender, and columella larger than in variety A; the same locality.

BALANOPHYLLIA ULRICHI, *Duncan.*

The corallum is cylindro-conical, slightly curved, has a small pedicel and a large open calice; the epitheca is dense and complete inferiorly; but above the costæ are uncovered and very well marked, equal, rather prominent, separate, and finely granular; the columella is small; the septa are slender; and

there are four cycles in six systems ; the fossa is deep and the margin thin. Height of corallum 6-10th inch, breadth of calice 3-10th inch. Locality No. 1, $1\frac{1}{2}$ mile west of Cape Otway, Victoria.

BALANOPHYLLIA TUBULIFORMIS, *Duncan.*

The corallum is tall, cylindrical, and tubular in shape ; there is no epitheca ; the costæ are equal, flat, vermiculate, and separated by distinct spaces ; the calice is circular in outline, rather less in calibre at the margin than elsewhere, very deep, and it has a wide margin ; the wall is stout and cellular ; the columella is small, and at the bottom of the deep fossa ; the septa are stout, and very granular ; and there are four cycles in six systems ; there is a very slight in-bending of the higher orders ; and the septal arrangment has very little of the Eupsammian type. Height of the corallum, 6-10th inch ; breadth of the calice, 3-10th inch. Locality : Muddy Creek, Hamilton Tertiaries, Victoria.

BALANOPHYLLIA CAMPANULATA, *Duncan.*

The corallum is pedicellate, has a slight constriction immediately above the small base, and expands regularly into an elongate bell-shape ; the epitheca exists inferiorly, but it is very delicate and permits the flat costæ to be distinguished ; the calice is elliptical, and the margin is slightly everted ; the wall is moderately developed ; the columella is large, long, spongy, and prominent ; the septa are stout ; there are four cycles ; and the septa of the fourth and fifth orders unite with the tertiary midway between the wall and the columella ; the tertiary septa, after the junction with the orders, are as large as the primary and secondary septa ; the laminæ are granular ; the costæ, where uncovered, are separated by distinct intercostal spaces with numerous foramina ; they are slightly unequal, and have both granulations and foramina on their flat external surface ; there are rarely more than two rows of granules, and they are scarce. Height of the corallum, 8-10th inch ; breadth of calice, 3-10th inch. Locality No. 4, clay beneath "coralline beds," near Cape Otway. It is associated with *Trigonia semiundulata.*

Genus HETEROPSAMMIA, *Ed. & H.*, 1848.

Corallum simple, straight, fixed in a univalve shell which it completely envelopes continuing to grow at the base during life-time; no epitheca; no costæ, but the exterior surface covered with fine striæ and closely marked with short twisted vermiform ridges composed of crowded granules; columella spongy and well developed; septa thickened exteriorly and spongy.

HETEROPSAMMIA MICHELINI, *Ed. & H.*

This coral is very short and has a large rounded swollen base, much larger than the calice which is a figure of 8. Specimens of doubtful locality have been brought to me. I am sure, however, that it occurs within the tropics of N.E. Australia, and of much larger size than the specimen figured by Milne Edwards, being as much as 20 mill. high, 25 long, and 20 broad.

HETEROPSAMMIA ELLIPTICA. N. S. Pl. 6, figs. 3, a, b.

Corallum approaching cylindrical, sloping somewhat towards the base which is very wide and encrusted with serpulæ, polyzoa, &c., so that the enclosed shell is not visible; no epitheca, but the surface densly covered with fine points or elongated granules, the irregular lines between which are somewhat wider than in the last species, the lines of the septa and the spongy texture is only seen near the calice but the whole surface is visibly perforated and velvety; calice elliptical, the sides of the long axis parallel, the short sides rounded, wall spongy and thick, principal septa conspicuously exsert; fossa one-third depth of columella, at the base on which the loose spongy broad columella is very visible; septa in six systems of five cycles, the 6th and 7th orders bending towards one another in all the systems, not uniting, but curving a little back ere uniting with the columella; these orders are thin and much expanded at the base of the fossa; the primaries and secondaries of equal thickness and expansion throughout; above they are the most conspicuous orders, but below the 6th and 7th quite eclipse them; tertiaries but little distinguished; 4th and 5th orders very inconspicuous, all faintly granular, ridged and serrated at the edge. Alt. 28, maj. axis 21, min. 13, depth of fossa 9.

Port Jackson, 16 fathoms. A larger specimen but greatly worn, cast up on the beach at Manning River. Many doubtful young specimens from dredge at Sydney Harbor.

Genus DENDROPHYLLIA, *De Blainville*, 1830.

Corallum compound and generally branched; corallites cylindrical or cylindro-turbinate, arising from buds; costæ fine vermiculate formed of grains always more simple near to the calice, where also they are straighter; calice tubercular; fossa deep; columella more or less developed and prominent; septa thin, close, not exsert.

M. Edwards separated from the genus all *Dendrophylliæ* which had the last cycle incomplete, but Prof. Verrill, and after him Dana, has shown that this peculiarity is sometimes present or absent in the same species, and therefore the genus *Cænopsammia* must be abandoned. There are species of the genus recent and fossil in Australia, the latter hitherto only found in Tasmania. *D. axifuga*, *D. coccinea*, *D. Gaimardi*, and *D. Urvillei* are reported as existing in New Zealand. They are not known to me as Australian. Capt. Hutton, the well known naturalist at Dunedin, assures me that they are not found in New Zealand. My own opinion is not only in this, but in many similar instances, that the specimens of the voyage of the Astrolabe got mixed, and that the many tropical corals quoted by Messrs. Q. and G. as from Australia and New Zealand, really came from the Pacific Islands within the tropics. Certain it is that very few of their Australian or New Zealand habitats can be verified.

EXPLANATION OF PLATES.

PLATE IV.

Fig. 1. a. *Calice of* SPHENOTROCHUS EXCAVATUS, *enlarged.*
b. *Side view of septum, enlarged.*
c. *Side view of corallum, enlarged.*

Fig. 2. FLABELLUM IRREGULARE, *nat. size.*

Fig. 3. a. *Corallum of* CYLICIA MAGNA, *nat. size.*

b. *Another specimen, nat. size.*

c. *Calice of fig.* 1, *a., enlarged.*

Fig. 4. *One system of* BALANOPHYLLIA BUCCINA, *much enlarged.*

PLATE V.

Fig. 1. a. CONOCYATHUS COMPRESSUS, *corallum enlarged.*

b. *Calice, much enlarged.*

Fig. 2. a. DELTOCYATHUS ROTÆFORMIS, *corallum enlarged.*

b. *Calice, enlarged.*

Fig. 3. a. CYLICIA QUINARIUM, *enlarged.*

b. *Calice, enlarged.*

c. *Secondary septum, much enlarged.*

d. *Septum of fourth order, much enlarged.*

e. *Tertiary septum, much enlarged.*

Fig. 4. a. DUNOCYATHUS PARASITICUS, *immersed in* LUNULITES CANCELLATA, *Busk., much enlarged.*

b. *Side view of Lunulite, enlarged* 4 *diam.*

Fig. 5. a. BALANOPHYLLIA BUCCINA, *nat. size.*

b. *Another specimen, nat. size.*

c. *Another specimen, nat. size.*

d. *The same seen across minor axis, nat. size.*

PLATE VI.

Fig. 1. a. ENDOPACHUS AUSTRALIÆ, *major axis of corallum nat. size.*

b. *Minor axis of same, nat. size.*

c. *Calice, much enlarged.*

Fig. 2. a. CRISPATOTROCHUS INORNATUS, *corallum enlarged* 2 *diam.*

b. *Calice, much enlarged.*

c. *Costæ, much enlarged.*

Fig. 3. a. HETEROPSAMMIA ELLIPTICA, *corallum nat. size.*

b. *Calice, enlarged.*